The Chaining Force

A Hypothesis on a Fundamental Relational Force Operating Across All Physical Scales

Version 2.0 — With Lagrangian Formulation

Judicael Brindel
Independent Researcher, Cotonou, Benin
ORCID: 0009-0007-4590-9874

March 2026

Abstract

We propose the existence of a fundamental tendency — the Chaining Force F_c — which drives matter toward increasingly complex structures across all physical scales, from atomic assemblies to galactic formation. Unlike classical forces, F_c has no fixed spatial direction: it operates through relational chaining between matter elements, with a global tendency toward structural ascent. We argue that stellar formation is its local success, black holes are its local failure caused by excessive accretion rate, and the known fundamental forces are its scale-dependent manifestations.

Version 2.0 introduces a Lagrangian formulation of the Chaining Force. We propose a scalar field $\phi(x,t)$ representing the local density of relational complexity, derive its equation of motion, and identify three regimes: gravitational collapse (young universe), competition (intermediate), and complexity ascent (old structures). All claims are speculative and clearly marked.

Contents

1 Motivation **3**

2 Definition and Properties **3**

3 The Scalar Field ϕ **3**

4 The Lagrangian **4**

5 Equation of Motion **4**

6 Three Physical Regimes **5**
6.1 Young universe: gravitational collapse ($\tau \to 0$) 5
6.2 Competition regime: intermediate τ 5
6.3 Old structures: complexity ascent ($\tau \gg 1$) 5

7 The Critical Threshold and Black Holes **6**

8 Calculating the Chaining Force **6**
8.1 Equilibrium field 6
8.2 The force 6
8.3 The critical age τ_{crit} 7
8.4 Connection to the Eddington limit 7
8.5 Physical prediction 8
8.6 Calibration on the Sun 8

9 Propagation Speed of the Chaining Force **9**
9.1 In vacuum 9
9.2 Near a massive body 10
9.3 At the black hole horizon 10

10 The Noise Field $\xi(x, t)$ **11**
10.1 The geometric origin of the zigzag 11

11 Connection to Known Physics **12**

12 The Chaining Force Inside a Black Hole **12**

13 Open Problems **13**

14 Summary **14**

1 Motivation

Newton observed an apple falling. Gravity pulls downward — toward existing mass, toward the centre. But matter also rises. A dispersed cloud of hydrogen becomes a star. Simple atoms become complex molecules. Molecules become life. The trajectory of matter over cosmic time is not downward — it is toward greater structure, greater complexity, greater connection.

This ascending tendency is not explained by gravity alone. Gravity explains why matter clumps. It does not explain why matter *organises* — why it forms stable, complex, interconnected structures rather than simply collapsing into undifferentiated mass.

We propose that this ascending tendency is the expression of a physical force — the Chaining Force — which operates at all scales through relational chaining. Its key property: it has no fixed spatial direction. It zigzags. Gravity cannot fully capture it because it does not point in a predictable direction. This is its escape mechanism.

2 Definition and Properties

Definition 1 (The Chaining Force F_c)**.** *The Chaining Force is a physical tendency with the following properties:*

1. ***Non-vectorial.*** *F_c has no fixed spatial direction. Its trajectory is locally irregular — zigzag, curved — but globally oriented toward increasing structural complexity.*
2. ***Relational.*** *F_c exists between matter elements, not within them. It requires at least two elements to manifest.*
3. ***Scalable.*** *The same force operates at all scales: atomic, molecular, planetary, stellar, galactic.*
4. ***Accumulative.*** *The strength of F_c on a structure grows linearly with the age of that structure: $|F_c| \propto \tau$, where τ is the accumulation time.*
5. ***Stochastic.*** *F_c is not deterministic. It creates local opportunities for structures to ascend. Some seize them; others do not.*
6. ***Threshold-limited.*** *If the rate of change exceeds a critical threshold $\dot{\phi}_{\text{crit}}$, gravity wins and the structure collapses.*

[Speculative]

Remark 1. *The non-vectorial, stochastic nature of F_c distinguishes it from all four known fundamental forces, which are described by vector or tensor fields with definite local directions. F_c is better described as a tendency in the space of configurations than as a force in physical space.*

3 The Scalar Field ϕ

To give the Chaining Force a mathematical form, we introduce a scalar field $\phi(x, t)$ representing the local density of relational complexity at spacetime point (x, t).

Definition 2 (Complexity field ϕ)**.** *$\phi(x,t) \in \mathbb{R}_{\geq 0}$ is the local density of relational complexity.*

- *$\phi \approx 0$: dispersed matter, low organisation (diffuse gas cloud)*
- *ϕ intermediate: organised structure (star, planetary system)*
- *$\phi \to \infty$: gravitational collapse (black hole)*

The Chaining Force is the physical tendency that drives ϕ from low to intermediate values — not toward zero (collapse) and not toward infinity (black hole), but toward the organised middle.

4 The Lagrangian

We propose the following Lagrangian density for the complexity field ϕ:

Definition 3 (Chaining Force Lagrangian)**.**

$$\mathcal{L} = \underbrace{\frac{1}{2}(\partial_\mu \phi)(\partial^\mu \phi)}_{\text{kinetic: complexity propagates}} - \underbrace{\frac{GM}{r}\phi^2}_{\text{gravity resists}} + \underbrace{\tau \cdot \xi(x,t) \cdot \phi}_{\text{Chaining Force pushes}} \tag{1}$$

with the constraint $\dot{\phi} < \dot{\phi}_{\text{crit}}$. ***[Speculative]***

Each term has a direct physical interpretation:

Term 1 — Kinetic. $\frac{1}{2}(\partial_\mu \phi)^2$ is the standard kinetic term for a scalar field. It encodes the fact that complexity propagates through spacetime — it is not frozen in place.

Term 2 — Gravitational resistance. $\frac{GM}{r}\phi^2$ is the gravitational potential term. It resists the ascent of ϕ. The closer to a massive body (small r), the stronger the resistance. This is the apple falling — gravity always pulls toward collapse.

Term 3 — Chaining Force. $\tau \cdot \xi(x,t) \cdot \phi$ is the source term. $\xi(x,t)$ is a stochastic noise field — non-vectorial, non-fixed, the mathematical expression of the zigzag. τ is the accumulation time of the structure. The amplitude of the Chaining Force grows linearly with age: old structures have stronger F_c.

Constraint. If $\dot{\phi} \geq \dot{\phi}_{\text{crit}}$, the structure accretes too fast for organisation to develop. Gravity wins. This is black hole formation.

5 Equation of Motion

Applying the Euler-Lagrange equations to (1):

$$\frac{\partial \mathcal{L}}{\partial \phi} - \partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu \phi)} = 0 \tag{2}$$

Computing term by term:

From the kinetic term: $\partial_\mu \partial^\mu \phi = \Box\phi$, contributing $-\Box\phi$.

From the gravitational term: $\frac{\partial}{\partial\phi}\left(-\frac{GM}{r}\phi^2\right) = -\frac{2GM}{r}\phi$, contributing $-\frac{2GM}{r}\phi$.

From the Chaining Force term: $\frac{\partial}{\partial\phi}\left(\tau\cdot\xi\cdot\phi\right) = \tau\cdot\xi(x,t)$, contributing $+\tau\cdot\xi(x,t)$.

The full equation of motion is:

$$\boxed{\Box\phi + \frac{2GM}{r}\phi = \tau\cdot\xi(x,t)} \tag{3}$$

where $\Box = -\partial_t^2 + \nabla^2$ is the d'Alembertian operator.

Remark 2. *Equation* (3) *is a* stochastic wave equation with effective mass. *The term* $\frac{2GM}{r}$ *plays the role of a position-dependent effective mass* $m_{\text{eff}}^2(r) = \frac{2GM}{r}$. *Near a massive body, the effective mass is large — complexity waves are suppressed. Far from massive bodies, complexity propagates freely.*

6 Three Physical Regimes

Equation (3) admits three natural regimes:

6.1 Young universe: gravitational collapse ($\tau \to 0$)

When $\tau \approx 0$, the Chaining Force term vanishes:

$$\Box\phi + \frac{2GM}{r}\phi \approx 0$$

This is a wave equation with positive effective mass squared — the solutions are damped. Gravity dominates entirely. Matter disperses or collapses. No organised structures form.

This is the early universe: matter exists, but the Chaining Force has not yet had time to act.

6.2 Competition regime: intermediate τ

For intermediate τ, both terms compete:

$$\Box\phi + \frac{2GM}{r}\phi = \tau\cdot\xi(x,t)$$

Some configurations receive enough stochastic forcing to overcome gravitational resistance and organise. Others do not. This is the regime of stellar and planetary formation.

The stochastic nature of ξ means the outcome is not deterministic — some matter clumps form stars; others collapse or disperse. The zigzag of F_c determines which configurations succeed.

6.3 Old structures: complexity ascent ($\tau \gg 1$)

When τ is large, the Chaining Force dominates:

$$\Box\phi \approx \tau\cdot\xi(x,t)$$

Gravity becomes negligible at large scales compared to the accumulated Chaining Force. Complexity propagates freely, driven by the stochastic source. This is the regime of galactic organisation and — speculatively — the emergence of life and civilisation.

7 The Critical Threshold and Black Holes

Proposition 1 (Black hole formation as threshold crossing)**.** *A black hole forms when the rate of change of ϕ exceeds the critical threshold:*

$$\dot{\phi} \geq \dot{\phi}_{\text{crit}}$$

At this point, the accretion rate is too high for relational complexity to develop. The Chaining Force is present but cannot manifest — the structure collapses before organisation can emerge.

Inside the black hole, F_c persists but operates without the possibility of outward structural expression. ***[Sketched]***

Remark 3. *This interprets black holes not as victories of gravity but as failures of complexity — matter that could not organise in time. The standard narrative is inverted: the most massive objects in the universe are not the most complex. They are the most failed.*

8 Calculating the Chaining Force

We now compute F_c explicitly from the Lagrangian and identify the critical age τ_{crit} at which the Chaining Force overcomes gravity.

8.1 Equilibrium field

In the stationary regime — the structure is not changing rapidly, $\Box\phi \approx 0$ — the equation of motion (3) reduces to:

$$\frac{2GM}{r}\phi = \tau \cdot \xi(x,t)$$

Solving for the equilibrium complexity field:

$$\phi_{\text{eq}}(r) = \frac{\tau \cdot \xi(x,t) \cdot r}{2GM} \tag{4}$$

The complexity field grows linearly with r and with τ — old structures, far from massive bodies, develop the highest complexity.

8.2 The force

The Chaining Force is the gradient of the potential $V(\phi) = \frac{GM}{r}\phi^2$ with respect to r:

$$F_c = -\frac{\partial V}{\partial r} = -\frac{\partial}{\partial r}\left(\frac{GM}{r}\phi^2\right) = \frac{GM}{r^2}\phi^2$$

Substituting ϕ_{eq} from (4):

$$F_c = \frac{GM}{r^2} \cdot \left(\frac{\tau \cdot \xi \cdot r}{2GM} \right)^2 = \frac{\tau^2 \cdot \xi^2 \cdot r^2}{4GM \cdot r^2}$$

Taking the statistical average over the noise $\langle \xi^2 \rangle$:

$$\boxed{F_c = \frac{\tau^2 \langle \xi^2 \rangle}{4GM}} \tag{5}$$

Remark 4. *Three properties of equation (5) are immediately notable:*

1. $F_c \propto \tau^2$ *— old structures are much stronger than young ones. Doubling the age quadruples the Chaining Force.*
2. $F_c \propto 1/GM$ *— massive bodies resist the Chaining Force more strongly.*
3. F_c *is* independent of r *in this regime — it has no preferred spatial direction. This is the mathematical expression of the non-vectorial property of* F_c*.*

8.3 The critical age τ_{crit}

The Chaining Force overcomes Newtonian gravity when $F_c > F_{\text{Newton}}$:

$$\frac{\tau^2 \langle \xi^2 \rangle}{4GM} > \frac{GM}{r^2}$$

Solving for τ:

$$\boxed{\tau_{\text{crit}}(r) = \frac{2GM}{r\sqrt{\langle \xi^2 \rangle}}} \tag{6}$$

Proposition 2 (Complexity condition)**.** *A structure at distance r from a mass M organises under the Chaining Force if and only if its age satisfies:*

$$\tau > \tau_{\text{crit}}(r) = \frac{2GM}{r\sqrt{\langle \xi^2 \rangle}}$$

If $\tau \leq \tau_{\text{crit}}$, gravity dominates: the structure collapses or remains dispersed. ***[Sketched]***

8.4 Connection to the Eddington limit

The critical accretion rate in astrophysics is set by the Eddington luminosity:

$$L_{\text{Edd}} = \frac{4\pi GMc}{\kappa}$$

where κ is the opacity of the accreting gas. We identify:

$$\dot{\phi}_{\text{crit}} = \frac{L_{\text{Edd}}}{c^2} = \frac{4\pi GM}{\kappa c} \tag{7}$$

This connects the abstract threshold $\dot{\phi}_{\text{crit}}$ to a measurable astrophysical quantity. When the accretion rate exceeds the Eddington limit, matter falls faster than the Chaining Force can organise it. The structure collapses to a black hole. **[Sketched]**

8.5 Physical prediction

Equation (6) makes a qualitative prediction consistent with observation:

- **Near galactic centres** (r small, M large): τ_{crit} is very large. Only extremely old structures can organise. Complex stellar systems and life are suppressed near supermassive black holes.
- **Far from galactic centres** (r large, M effectively smaller): τ_{crit} is smaller. Even relatively young structures can organise. Stars, planetary systems, and life form more readily.

This is consistent with observations of star formation rates across galactic environments. **[Sketched]**

8.6 Calibration on the Sun

The single free parameter $\langle \xi^2 \rangle$ can be estimated by calibrating the theory on a known case. We use the Sun.

Calibration hypothesis: the Sun is at the limit of the complexity condition — $\tau_\odot = \tau_{\text{crit}}$. That is, the Sun is the youngest structure that could have organised in its galactic environment.

Parameters:

Parameter	Value	Source
G	6.674×10^{-11} m^3 kg^{-1} s^{-2}	CODATA 2018
$M_\odot$	1.989×10^{30} kg	IAU
$\tau_\odot$	4.6×10^9 yr $= 1.452 \times 10^{17}$ s	geochronology
r	2.6×10^{20} m (8.5 kpc)	galactic centre distance

From $\tau_{\text{crit}} = \tau_\odot$:

$$\sqrt{\langle \xi^2 \rangle} = \frac{2GM_\odot}{r \cdot \tau_\odot} = \frac{2 \times 6.674 \times 10^{-11} \times 1.989 \times 10^{30}}{2.6 \times 10^{20} \times 1.452 \times 10^{17}} = 7.03 \times 10^{-18} \text{ m}^2\text{s}^{-3}$$

$$\boxed{\langle \xi^2 \rangle = 4.95 \times 10^{-35} \text{ m}^4\text{s}^{-6}} \tag{8}$$

The Chaining Force amplitude on the Sun:

$$F_c(\odot) = \frac{\tau_\odot^2 \langle \xi^2 \rangle}{4GM_\odot} = \frac{(1.452 \times 10^{17})^2 \times 4.95 \times 10^{-35}}{4 \times 6.674 \times 10^{-11} \times 1.989 \times 10^{30}} = 1.96 \times 10^{-21} \text{ N}$$

For comparison, the Newtonian gravitational force on the Sun from the galaxy ($M_{\text{gal}} \approx 10^{12} M_\odot$):

$$F_{\text{Newton}} = \frac{GM_{\text{gal}}M_{\odot}}{r^2} = 3.91 \times 10^{21}\ \text{N}$$

$$\frac{F_c}{F_{\text{Newton}}} \approx 5 \times 10^{-43}$$

Remark 5. *The Chaining Force is 10^{43} times weaker than Newtonian gravity in this regime. This is not a weakness of the theory — it is its nature. The Chaining Force does not compete with gravity on human timescales. It acts over billions of years, slowly, in no fixed direction, accumulating complexity link by link. The smallness of F_c/F_{Newton} is why we did not detect it before. It is why it took 4.6 billion years to produce the Sun — and why that is not nothing.*

τ_{crit} across galactic environments:

Environment	r **(m)**	τ_{crit} **(yr)**
Near Sgr A* (0.1 pc)	3.1×10^{15}	1.5×10^{21}
Near Sgr A* (1 pc)	3.1×10^{16}	1.5×10^{20}
Solar neighbourhood	2.6×10^{20}	4.6×10^{9}
Outer galaxy (20 kpc)	6.2×10^{20}	1.9×10^{21}

Remark 6 (Open problem)**.** *Near Sgr A*, $\tau_{\text{crit}} \sim 10^{21}$ yr — far exceeding the age of the universe. The model in its current form predicts that no structure can ever organise near a supermassive black hole, which is too strong: observations show star formation at a few parsecs from Sgr A*.*

This signals a limitation of the present Lagrangian near extreme gravitational environments. A saturation term in $V(\phi)$ — for instance $V(\phi) = \frac{GM}{r}\phi^2 - \frac{\lambda}{4}\phi^4$ — or a modified dependence of τ_{crit} on r in high-density regimes may resolve this. This is left as an open problem for v3. ***[Open]***

9 Propagation Speed of the Chaining Force

We derive the speed at which the complexity field ϕ propagates through spacetime, and what happens to that speed near a massive body.

9.1 In vacuum

Far from any mass ($GM/r \to 0$) and without source ($\tau \cdot \xi \approx 0$), the equation of motion (3) reduces to:

$$\Box\phi = 0 \implies -\partial_t^2\phi + \nabla^2\phi = 0$$

This is the standard wave equation. A plane wave solution $\phi = \phi_0\, e^{i(kx-\omega t)}$ gives the dispersion relation:

$$-\omega^2 + k^2 = 0 \implies \omega = k$$

The propagation speed:

$$\boxed{v_{\text{vacuum}} = \frac{\omega}{k} = c} \tag{9}$$

In vacuum, the Chaining Force propagates at the speed of light.

9.2 Near a massive body

With the gravitational resistance term restored:

$$\Box\phi + \frac{2GM}{r}\phi = 0$$

The dispersion relation becomes:

$$\omega^2 = k^2 + \frac{2GM}{r}$$

The group velocity — the speed at which information propagates:

$$v_g = \frac{d\omega}{dk} = \frac{k}{\sqrt{k^2 + \frac{2GM}{rc^2k^2} \cdot k^2}} = \frac{c}{\sqrt{1 + \frac{2GM}{rc^2k^2}}} \tag{10}$$

Since $\frac{2GM}{rc^2k^2} > 0$, we have $v_g < c$ always. **Gravity slows the propagation of complexity.**

9.3 At the black hole horizon

At the Schwarzschild radius $r_s = 2GM/c^2$:

$$\frac{2GM}{r_s c^2} = 1$$

From (10), as $r \to r_s$:

$$\boxed{v_g \to 0} \tag{11}$$

The Chaining Force stops completely at the horizon of a black hole.

Remark 7. *This result deepens the interpretation of black holes as failures of complexity. It is not only that the accretion rate is too high for organisation to develop (the $\dot{\phi}_{\text{crit}}$ condition). It is that at the horizon, the Chaining Force cannot propagate at all. The field ϕ freezes. Complexity cannot move forward. The chain breaks.*

This is the Lagrangian expression of what was already proposed in v1: a black hole is not a victory of gravity. It is the place where the Chaining Force goes silent.

Environment	r	v_g
Vacuum	∞	c
Solar neighbourhood	8.5 kpc	$\approx c$ (negligible correction)
Near a star	$\sim r_\odot$	$< c$ (small correction)
Near a black hole	$r \to r_s$	$\to 0$
Inside the horizon	$r < r_s$	undefined

[Sketched]

10 The Noise Field $\xi(x,t)$

The stochastic field $\xi(x,t)$ encodes the non-vectorial, unpredictable nature of F_c. We propose it is not white noise but a *long-memory noise* — correlated over cosmological timescales:

$$\langle \xi(x,t)\, \xi(x',t') \rangle \sim |t - t'|^{-\alpha}, \quad 0 < \alpha < 1 \tag{12}$$

A power-law correlation. This is the mathematical expression of the fact that the Chaining Force has memory — each zigzag leaves a trace that influences future zigzags. It is not random chaos; it is structured randomness that produces order over billions of years.

The exponent α is an open parameter of the theory. **[Open]**

10.1 The geometric origin of the zigzag

In v1, the non-vectorial, zigzag nature of F_c was a postulate — a definition. The Lagrangian formulation and the propagation result of Section 7 give it a deeper explanation.

Since $v_g = c$ in vacuum, the Chaining Force propagates on the null geodesics of spacetime — the same paths followed by light. In flat spacetime, null geodesics are straight lines. But the universe is not flat. Every mass curves spacetime. Every star, every galaxy, every concentration of matter bends the null geodesics in its neighbourhood.

Proposition 3 (Geometric origin of the zigzag)**.** *The non-vectorial, zigzag character of F_c is not arbitrary randomness. It is the imprint of spacetime curvature on the null geodesics along which ϕ propagates. In a universe filled with matter at all scales, the null geodesics form a complex, curved, unpredictable network. The Chaining Force follows this network — not in a fixed direction, but along whatever paths spacetime geometry makes available.*

The stochastic field $\xi(x,t)$ is therefore not pure noise. It encodes the local curvature of spacetime as seen by the propagating field ϕ. Each mass encountered deflects F_c slightly — as it deflects light. Over billions of years, across a universe full of masses at all scales, the accumulated deflections produce the zigzag. ***[Speculative]***

Remark 8. *This gives $\xi(x,t)$ a geometric meaning. In flat spacetime, $\xi = 0$ and F_c propagates in a straight line at c — no zigzag. In curved spacetime, $\xi \neq 0$ and the path bends. The more massive and complex the environment, the richer the curvature, the more ξ varies, the more the Chaining Force zigzags.*

The universe organises itself precisely because it is full of masses that curve spacetime — and those curves are what give F_c its unpredictable, non-vectorial character. Gravity does not only resist the Chaining Force. It also shapes the paths the Chaining Force can take.

11 Connection to Known Physics

Conjecture 1 (Four forces as manifestations of F_c)**.** *The four known fundamental forces — strong nuclear, electromagnetic, weak nuclear, and gravitational — are scale-dependent manifestations of the Chaining Force:*

- *Strong nuclear: F_c at the quark-nucleon scale*
- *Electromagnetism: F_c at the atomic-molecular scale*
- *Weak nuclear: F_c at the nuclear decay scale*
- *Gravity: the resistance term in (1) — the opposing force that F_c must overcome*

[Open]

Remark 9 (Connection to Noether's theorem)**.** *The Lagrangian (1) is not time-translation invariant — the τ term breaks this symmetry explicitly. By Noether's theorem, energy is therefore not conserved in the standard sense for ϕ. This is physically correct: the Chaining Force* stores *energy in structures over time. The energy of a structure is not constant — it grows with τ. This is the Lagrangian expression of the Temporal Energy Proportionality $E_{\text{released}} \propto \tau_{\text{accumulation}}$.*

12 The Chaining Force Inside a Black Hole

The propagation result of Section 7 raises a deep question: if $v_g \to 0$ at the horizon, what happens to the Chaining Force inside?

It cannot exit. Once matter has fallen past the horizon, the Chaining Force it carries cannot propagate outward — $v_g = 0$ is a wall. The chain cannot reach back.

But it entered by chaining. Every atom now inside the black hole arrived there link by link, driven by the Chaining Force over billions of years. The force did not disappear when the matter crossed the horizon. It crossed with it.

Proposition 4 (Chaining Force as interior reservoir)**.** *The interior of a black hole contains the accumulated Chaining Force of all matter that fell into it — billions of years of complexity tendency, trapped behind the horizon. The force is present, active, continuing to chain — but with no outward expression possible.*

The black hole is not a cemetery of complexity. It is a sealed reservoir of accumulated chaining — matter and its tendency toward organisation, confined together, waiting. ***[Speculative]***

Remark 10. *This resolves the apparent contradiction between two statements:*

1. *The Chaining Force stops at the horizon ($v_g = 0$) — it cannot pierce the black hole from outside.*

2. *The Chaining Force is inside the black hole — it entered with the matter, link by link, over cosmic time.*

Both are true simultaneously. The horizon is a one-way boundary for F_c: matter and its accumulated chaining can fall in, but the force cannot propagate back out. The black hole accumulates F_c without releasing it.

Remark 11 (Connection to Hawking radiation)**.** *Hawking radiation provides a slow quantum leakage of energy from the black hole over cosmological timescales. If the Chaining Force is a physical field ϕ, one may ask: does Hawking radiation carry ϕ-quanta outward? Does the accumulated Chaining Force eventually escape, slowly, as the black hole evaporates?*

If so, the complete evaporation of a black hole would not only release mass-energy (as in the standard picture) but also the accumulated Chaining Force of billions of years of matter — a delayed release of complexity tendency into the universe. This would be the Cosmic Lavoisier Principle at its most extreme: nothing is lost, not even the tendency toward organisation. ***[Open]***

13 Open Problems

1. **Identification of $\dot{\phi}_{\text{crit}}$.** The connection to the Eddington luminosity (7) is proposed. A rigorous derivation from the Lagrangian dynamics is needed. **[Open]**
2. **Exponent α.** Determine the power-law exponent of the noise correlation from first principles or from observation. **[Open]**
3. **Coupling to gravity.** Extend the Lagrangian to curved spacetime by replacing $\partial_\mu \to \nabla_\mu$ and coupling ϕ to $g_{\mu\nu}$. Near the horizon, the metric becomes singular — the behaviour of ϕ in this regime requires careful treatment. **[Open]**
4. **Interior dynamics.** What does F_c do inside the black hole? Does it continue to organise matter toward new configurations beyond the singularity? Is there a chaînon beyond the black hole stage? **[Open]**
5. **F_c in Hawking radiation.** If ϕ is quantised, do Hawking quanta carry F_c? Does black hole evaporation release accumulated Chaining Force? **[Open]**
6. **Saturation near Sgr A*.** The current Lagrangian predicts $\tau_{\text{crit}} \sim 10^{21}$ yr near supermassive black holes — exceeding the age of the universe. A saturation mechanism in $V(\phi)$ is needed. **[Open]**
7. **Experimental signature.** The stochastic wave equation predicts a specific statistical distribution of complexity across scales. Does this match the observed distribution of stellar and galactic masses? **[Open]**
8. **Quantisation.** Can ϕ be quantised? What are the quanta of the Chaining Force? **[Open]**

14 Summary

Element	Expression	Status
Complexity field	$\phi(x,t)$	**[Speculative]**
Lagrangian	$\mathcal{L} = \frac{1}{2}(\partial\phi)^2 - \frac{GM}{r}\phi^2 + \tau\xi\phi$	**[Speculative]**
Equation of motion	$\Box\phi + \frac{2GM}{r}\phi = \tau \cdot \xi(x,t)$	**[Speculative]**
Young universe regime	$\Box\phi + \frac{2GM}{r}\phi \approx 0$	**[Sketched]**
Old structure regime	$\Box\phi \approx \tau \cdot \xi$	**[Sketched]**
Black hole threshold	$\dot{\phi} \geq \dot{\phi}_{\text{crit}} = 4\pi GM/\kappa c$	**[Sketched]**
Calibrated $\langle\xi^2\rangle$	4.95×10^{-35} m^{4}s^{-6} (solar)	**[Sketched]**
Speed in vacuum	$v_g = c$	**[Sketched]**
Speed at horizon	$v_g \to 0$	**[Sketched]**
F_c interior black hole	Trapped reservoir of chaining	**[Speculative]**
Noise exponent α	$\langle\xi\xi\rangle \sim \lvert t - t'\rvert^{-\alpha}$	**[Open]**
Four forces as F_c	Conjecture 1	**[Open]**
Interior dynamics	Open	**[Open]**

Central equation:

$$\Box\phi + \frac{2GM}{r}\phi = \tau \cdot \xi(x,t)$$

Matter does not only fall. It rises — slowly, through relational chaining, toward greater complexity. Gravity resists. The Chaining Force zigzags past it. Old structures win. Young ones collapse. At the horizon, the force goes silent — but it is already inside, accumulated over billions of years, waiting. The black hole is not where the chain ends. It is where it waits.

References

[1] J. Brindel, *Relational Emergence Complexity Theory (RECT)*, Zenodo (2026), DOI: 10.5281/zenodo.18860518.

[2] J. Brindel, *The Chaining Force* (v1.0), Zenodo (2026), DOI: 10.5281/zenodo.18863588.

[3] J. Brindel, *A Derivation of the CMB Temperature from Atomic Constants*, Zenodo (2026), DOI: 10.5281/zenodo.18848649.

[4] J. Brindel, *The Cosmic Lavoisier Principle*, Zenodo (2026), DOI: 10.5281/zenodo.18865054.

[5] E. Chaisson, *Cosmic Evolution: The Rise of Complexity in Nature*, Harvard University Press (2001).

[6] R. Penrose, *Gravitational collapse and space-time singularities*, Phys. Rev. Lett. **14** (1965) 57–59.

[7] S. W. Hawking, *Black hole explosions?*, Nature **248** (1974) 30–31.

[8] E. Noether, *Invariante Variationsprobleme*, Nachr. Ges. Wiss. Göttingen (1918) 235–257.